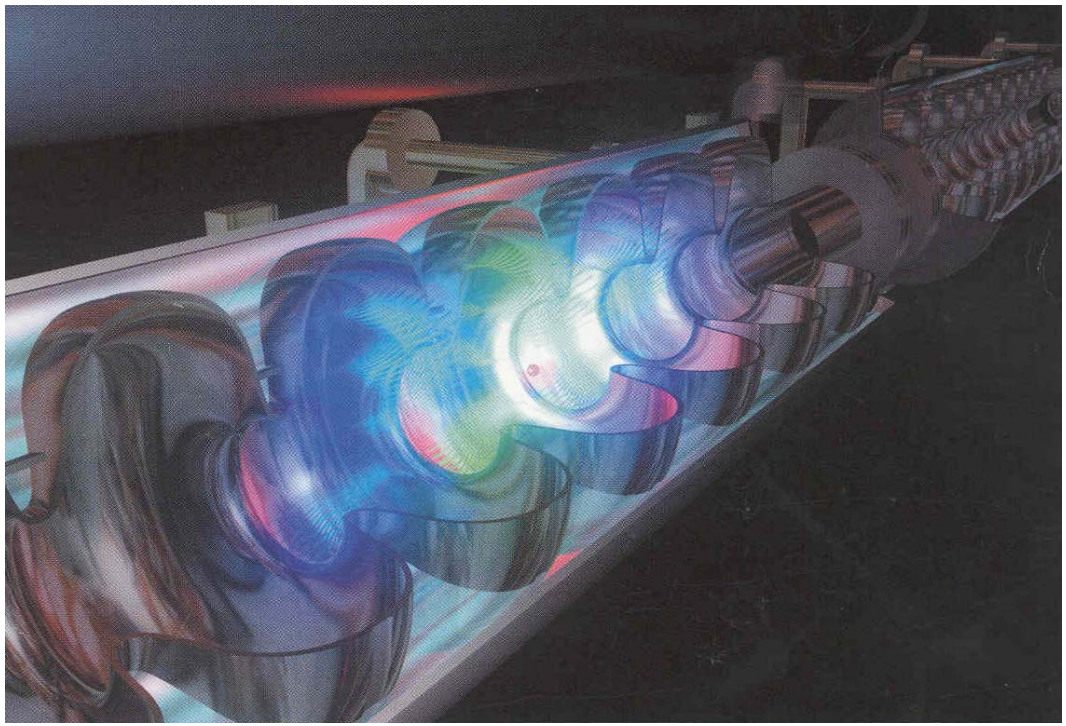
FERMILAB/NICADD PHOTOINJECTOR LABORATORY



H. Julia Brito
SIST Program
Tuesday, August 6, 2002

PERSONAL BACKGROUND

- Undergraduate at The University of Texas in Austin
- Mechanical Engineering
- Concentration in Biomedical Engineering

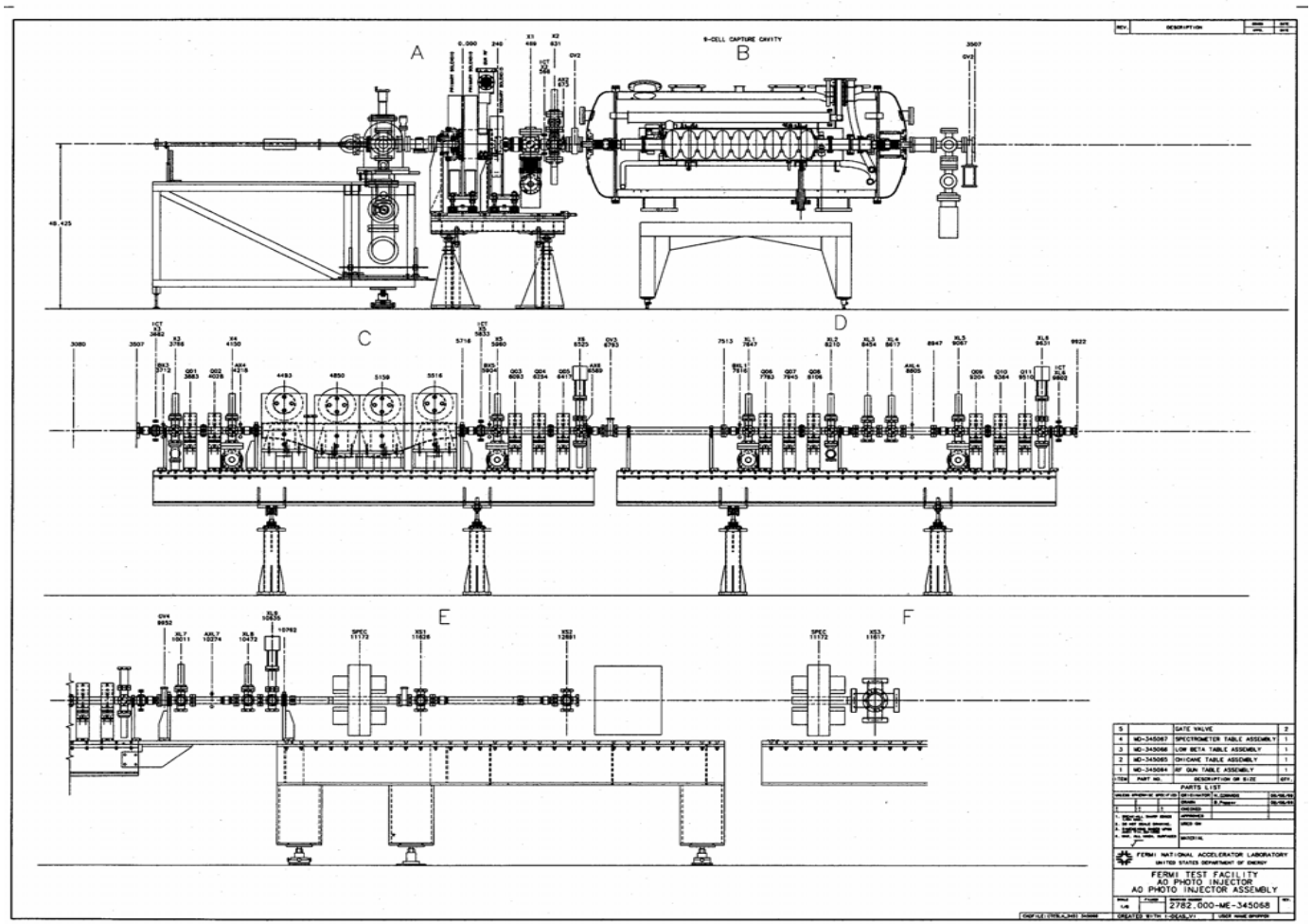
TEMP HOME @ FERMI

- Location
  - A- Zero
  - Beams Division
  - Research and Development lab
- Family
  - DESY = Deutsches Elektronen-Synchrotron (Germany)
  - NICADD = Northern Illinois Center for Accelerator Detector and Development
  - LBNL = Lawrence Berkeley National Laboratory
  - University of Rochester

OUTLINE

- Brief tour of A0 Photoinjector beam line
- Short discussion of work with diagnostic apparatus
- Concise summary of future goals
  - Photoinjector lab
  - Personal

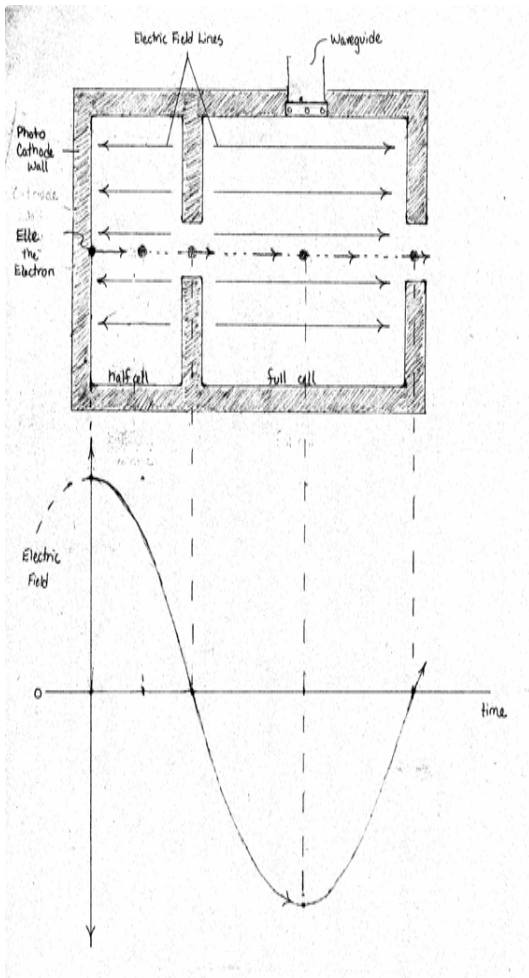
PHOTOINJECTOR BEAM LINE SCHEMATIC



KLYSTRON FOR PHOTO-CATHODE GUN

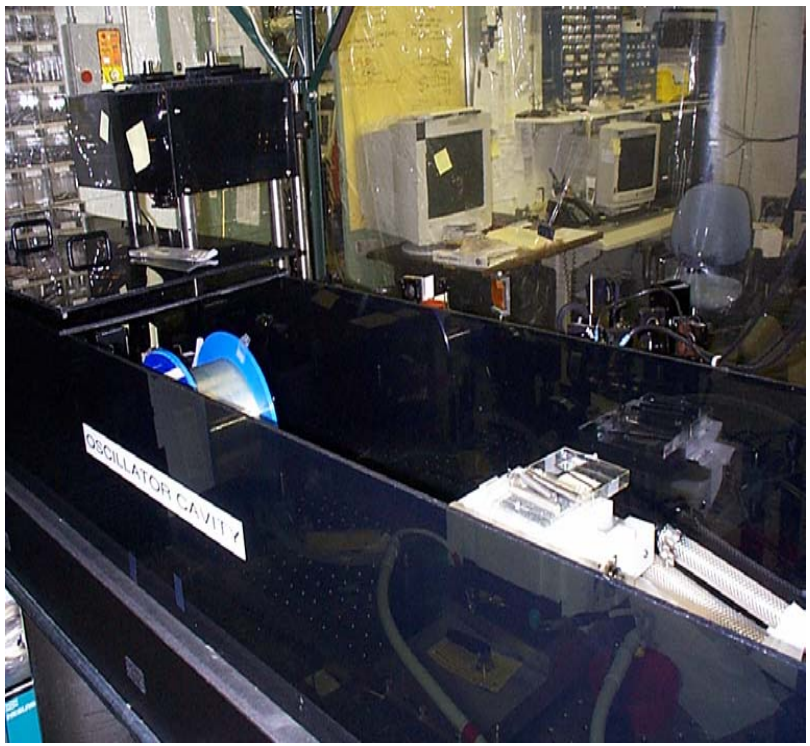
- Output power = 3 MW
- Located outside of beam line cave
- Radio Frequency (RF) waves @ 1.3 GHz travel via a waveguide—minimal losses for higher frequencies

ENTERING THE CAVE

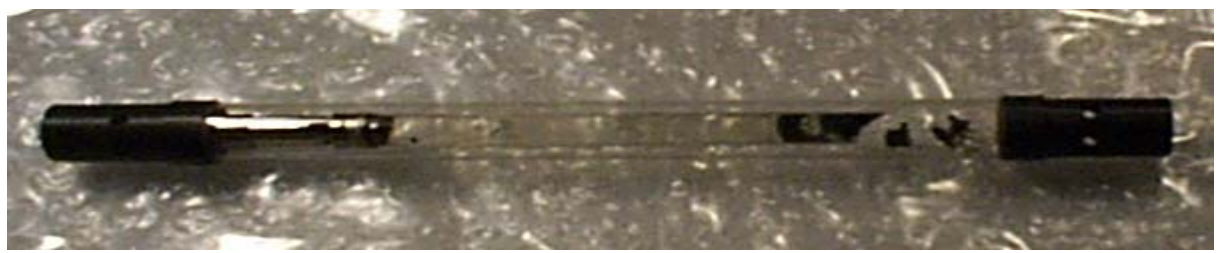


- RF waves produce electric field in 1.5 cell cavity
- Phase timing is crucial for electrons produced by cathode prep chamber to be accelerated
- Solenoids encircle the cathode gun for electron compression and focus
- Something needed to initially pick off electrons

CLASS IV LASER

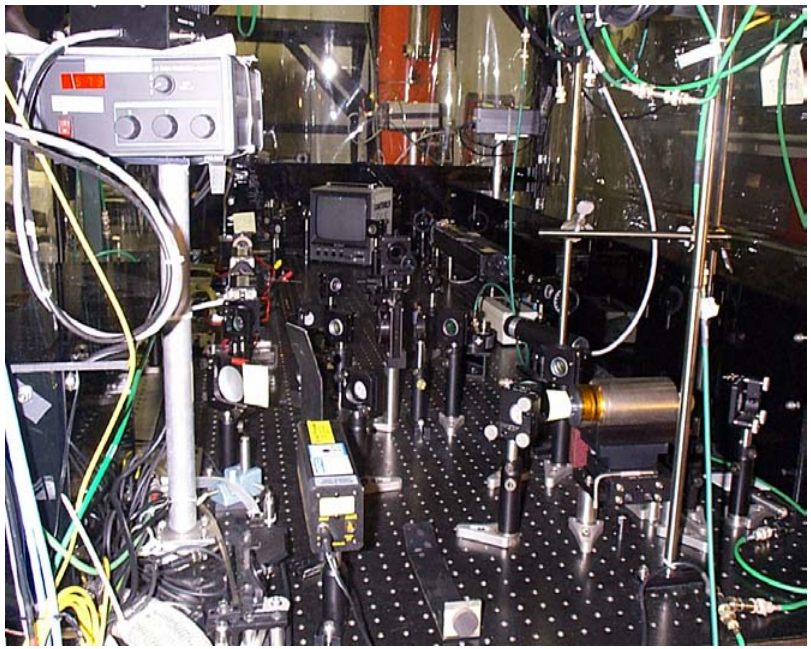


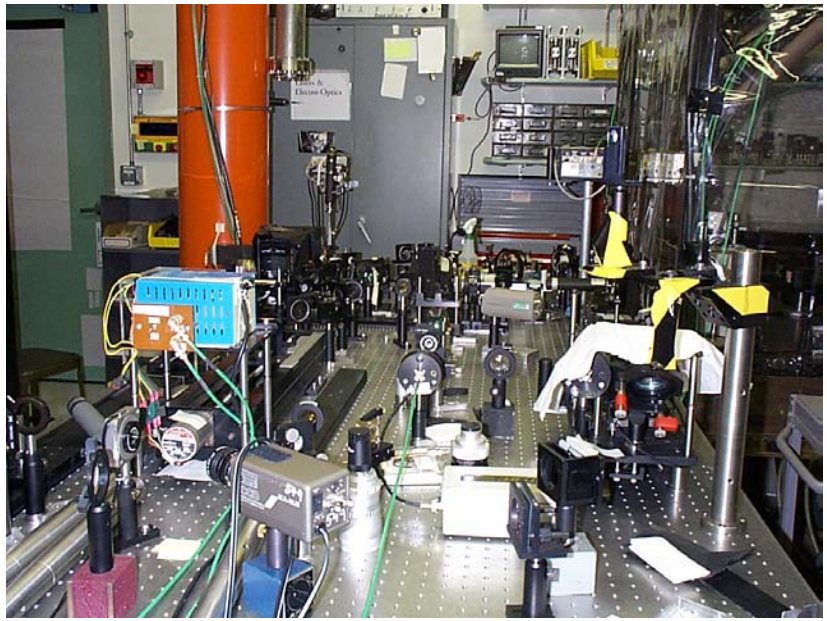
- Laser beam is created in oscillator cavity
- Many components, more things to go wrong
- Problems are not-so-obvious (lamp strike failure)



INFRARED TO ULTRAVIOLET LIGHT

Multi-pass stages used to amplify energy of the laser

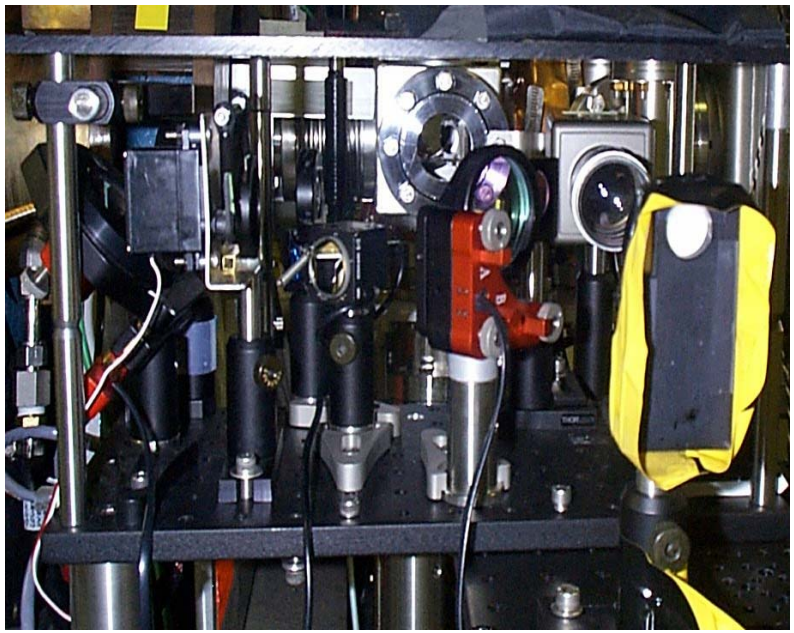




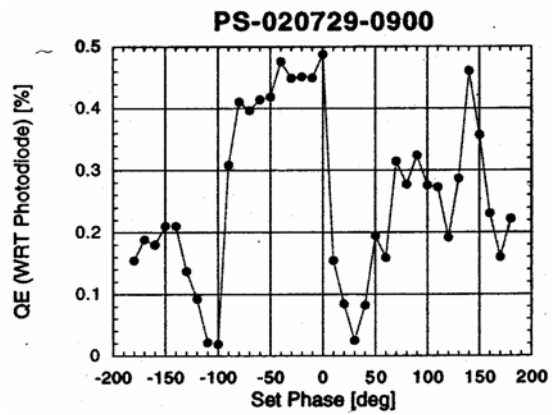
IR is converted to UV via doubling crystals and is guided into the cave

LASER ENTERS THE BEAM LINE

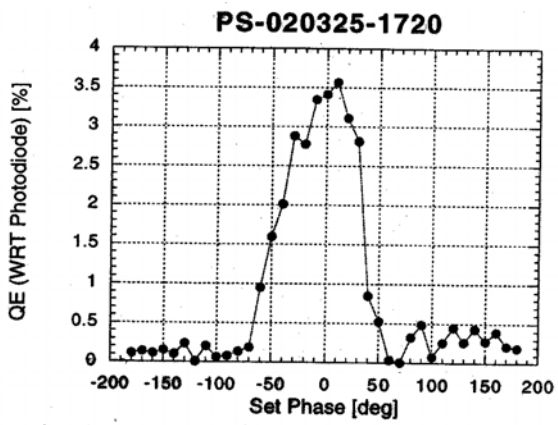
Quantum Efficiency = # of electrons / photon



Laser optics in cave
(Remote-control Iris)

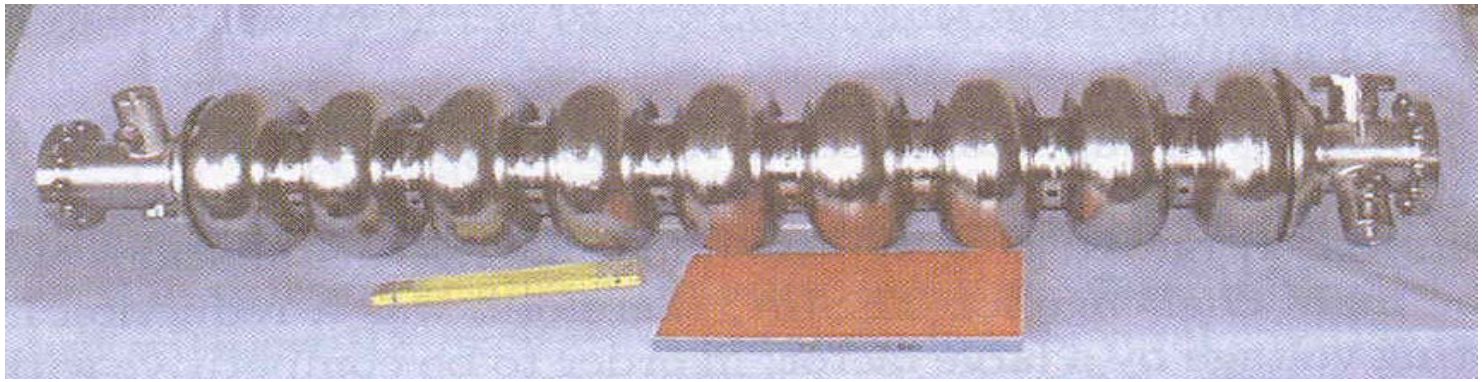


Bad phase scan



Good phase scan

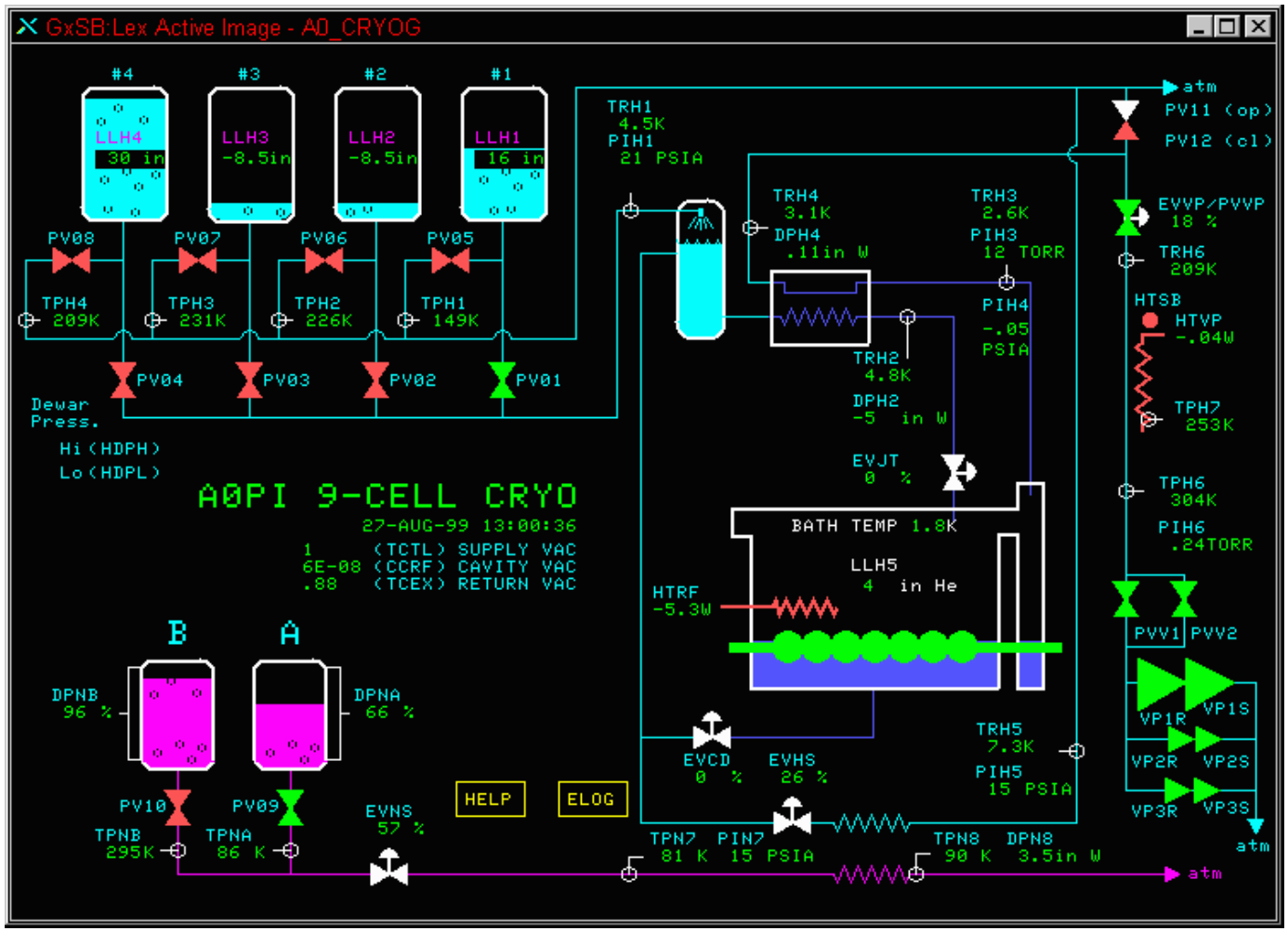
NINE CELL SUPER-CONDUCTING CAVITY



*Each cell progressively steps up the acceleration of the electrons

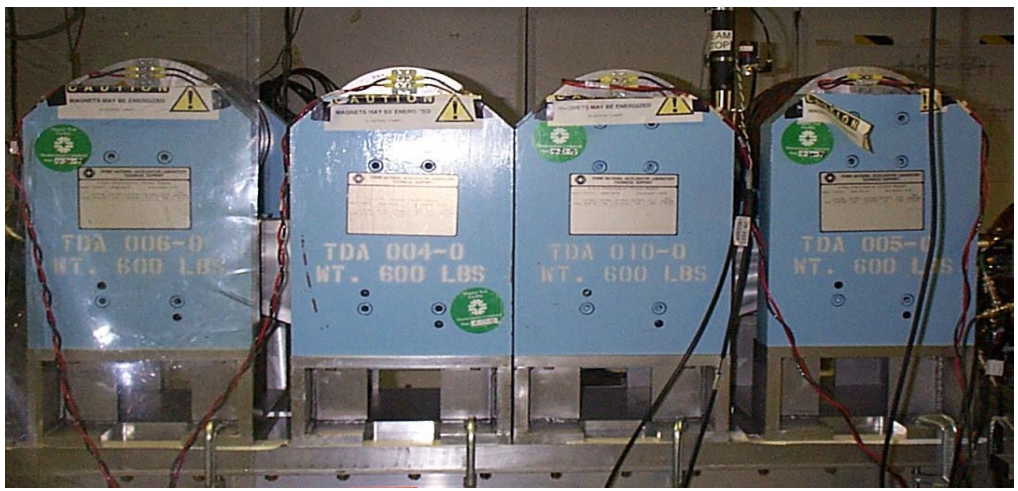
*Energy of the electrons increases from ~4 MeV to ~17 MeV

CRYOGENIC MONITOR OF 9 – CELL



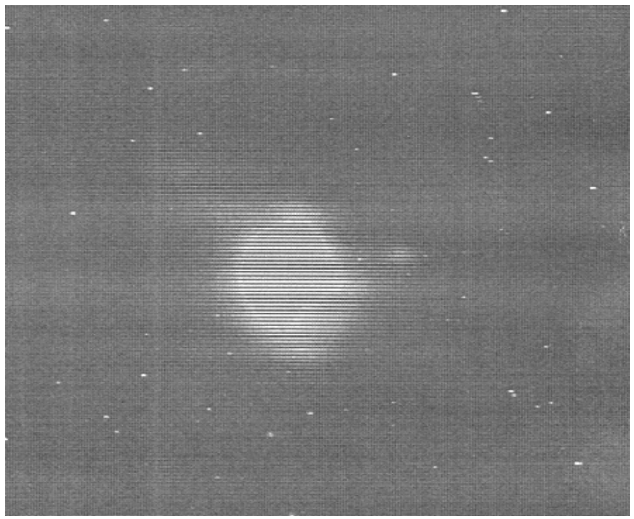
MAGNETS

- Dipole magnets: used for steering
- Quadrupole magnets: used for focusing; focuses in the transverse plane i.e. focuses in dimension of space
- Chicane: consists of 4 dipole magnets; steers beam down,straight, up, & straight again; focuses in the longitudinal plane i.e. focuses in dimension of time



END OF THE BEAM LINE

Spectrometer = magnet used to measure the energy at the end of the beam line

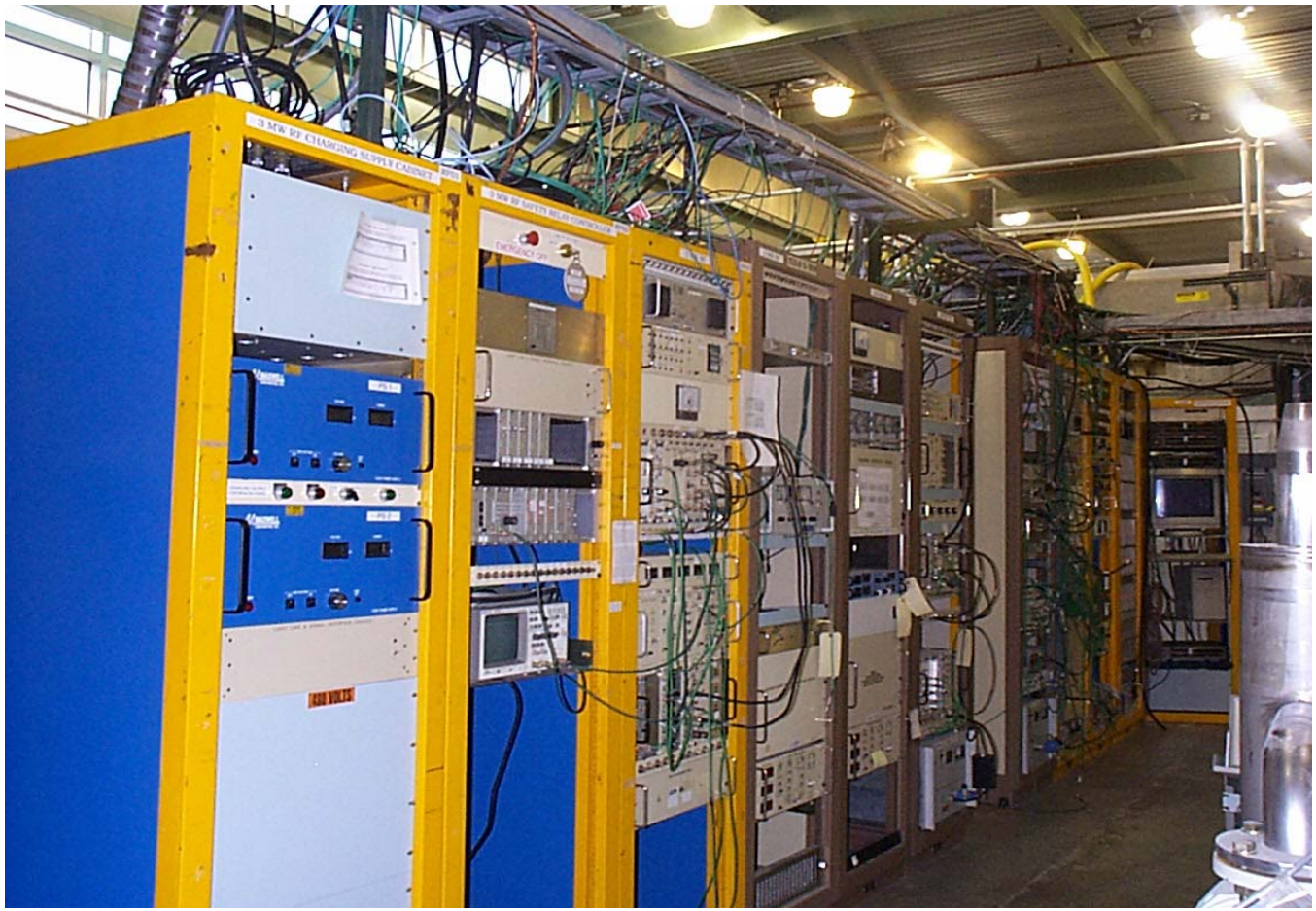


Total Energy =

$$\text{sqrt}((1.54*I_{spec})^2 + 0.511^2)$$

MULT	3.000	MULT CONTROLLER	!	3.000	_	N/A
SOLMN	1.000	SOLENOID MAIN	*	179.999	s	A
SOLBUC	1.000	SOLENOID BUCKING	*	189.998	s	A
SOLSEC	1.000	SOLENOID SECONDAR	*	180.003	s	A
PSPECT	0.200	SPECTROMETER PS	*	9.496	s	A
CAMCTL	1.000	AVMS CNTL	*	!undefined	s	... EN
FCUPX2	1.000	ACT#1 FCUPX2	*	!undefined	s	...OUT
FLAGX2	1.000	ACT#2 FLAGX2	*	!undefined	s	...OUT
FLAGX3	1.000	ACT#3 FLAGX3	*	!undefined	s	...OUT

TURNING ON!



DIAGNOSTICS

- A-Zero Control Room
  - Parameter pages
  - Oscilloscope readings
  - Data acquisition
- Cameras measure transverse bunch profile
- Interferometer measures longitudinal bunch length

INTERFEROMETER @ XL4

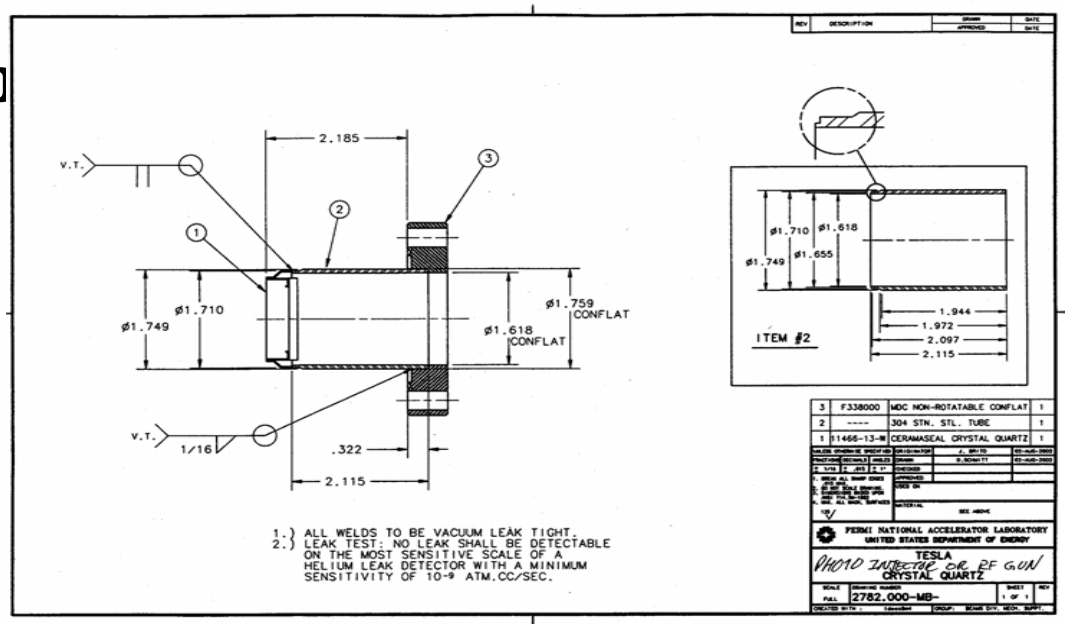
Best approach would be to work without windows
i.e. have the interferometer be a part of the beam line

However this type of interferometer would:
*be hard to align
*cost ~$50,000

Solution:
Insert flag in beam line @ 45º angle and design
a customized viewport

VIEWP

- Crystalline quartz window
- Stainless steel recessed tube and flange
- Vacuum tight conditions



INTERFEROMETER DESIGN

Designer:
Uwe Happek
@ The Univ.
of Georgia

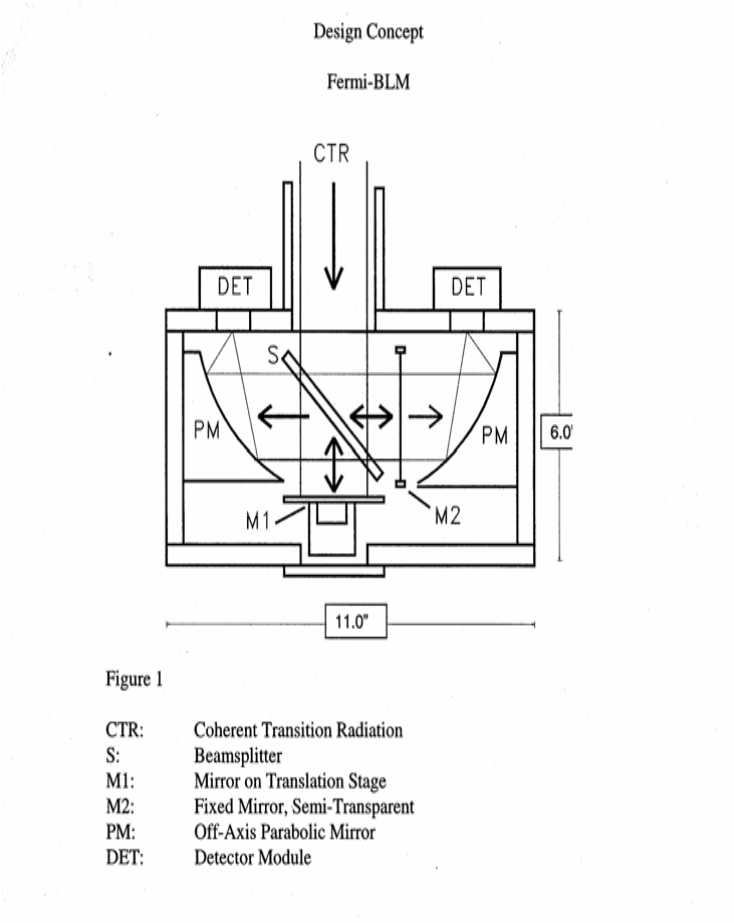
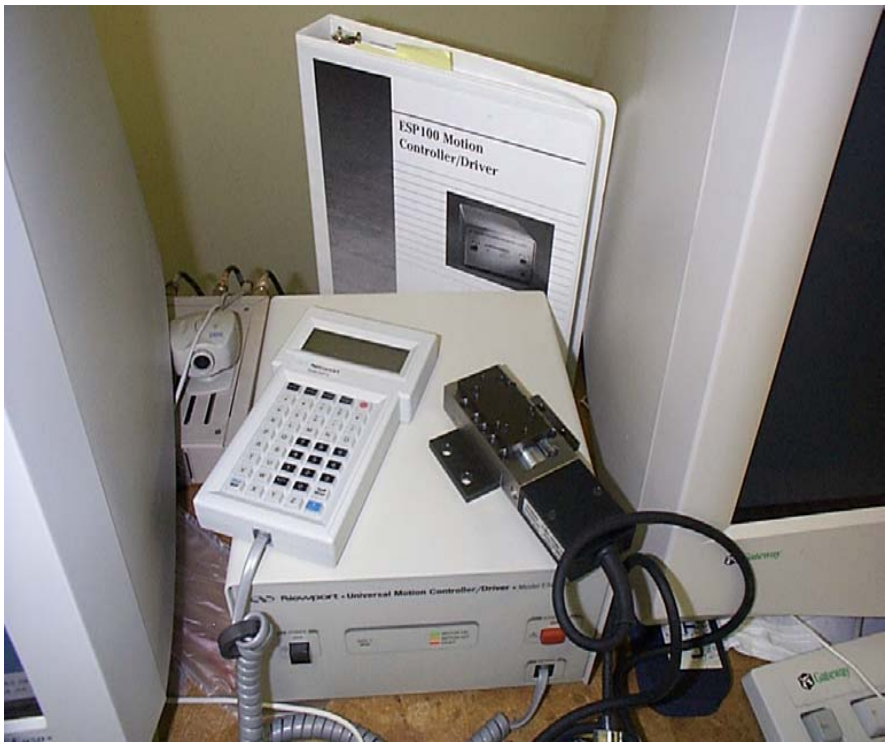


Figure 1

CTR:	Coherent Transition Radiation
S:	Beamsplitter
M1:	Mirror on Translation Stage
M2:	Fixed Mirror, Semi-Transparent
PM:	Off-Axis Parabolic Mirror
DET:	Detector Module

Purpose:
detectors use an inverse Fourier transform to reflect shape of electron distribution in bunch

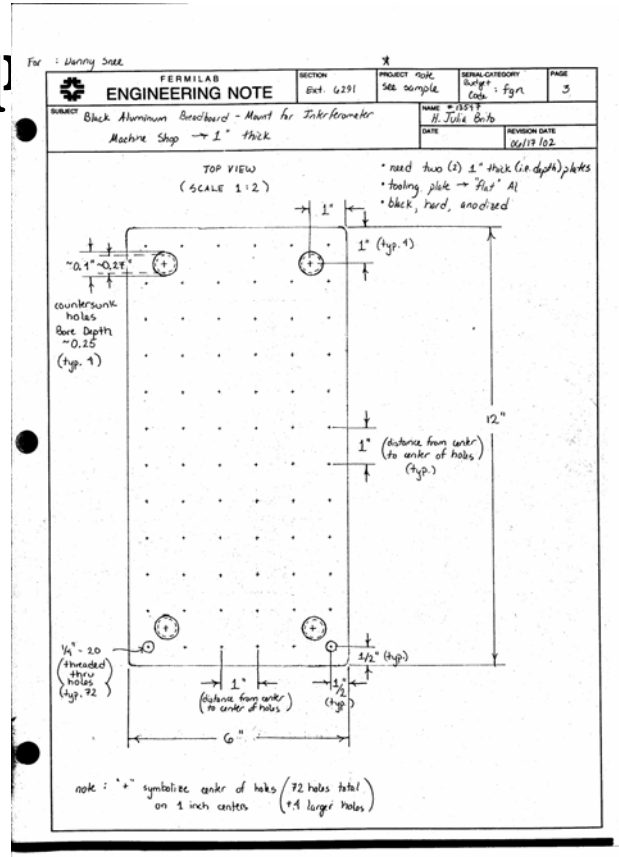
TRANSLATION STAGE

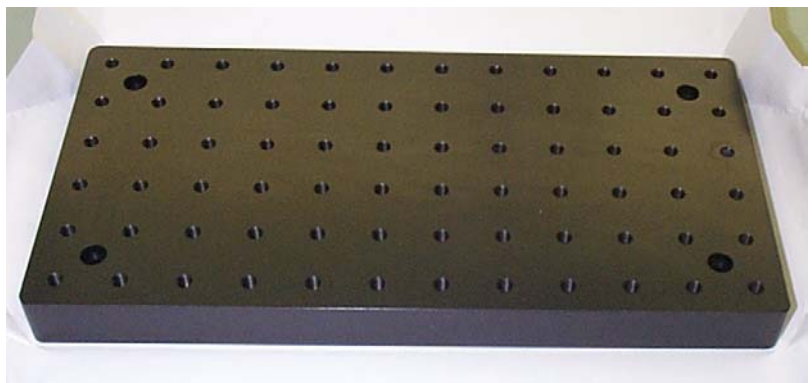


- Controller/keypad/motor stage system
- Communicate with manufacturers for correct setup
- Labview interface

STABLE P

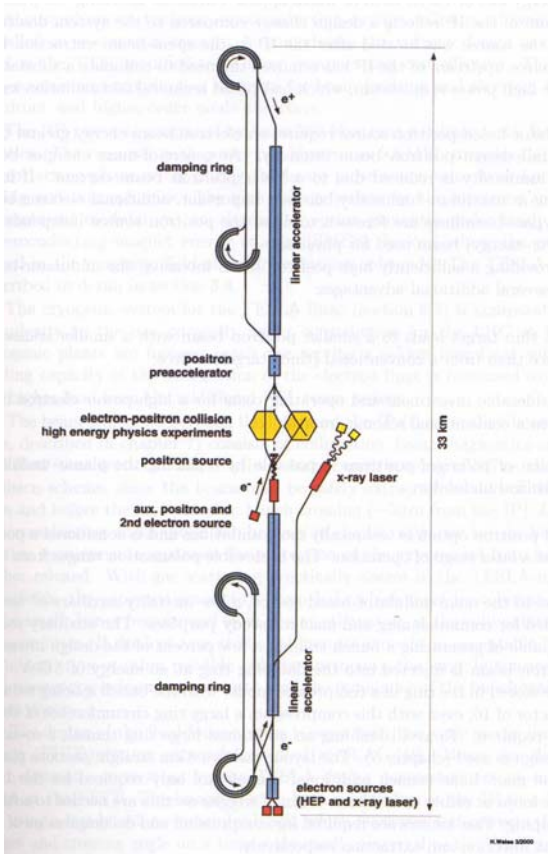
- Drawing
- Machining
- Polishing
- Packaging
- Shipping





FUTURE GOALS…

…of A-Zero Photoinjector Lab



…of a little Texan intern

Biomedical Optics,
Cell/Tissue Engineering,
Nanotechnology,
Biomedical Instrumentation,
Prosthetic Engineering, etc.